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BACKGROUND MEMORANDUM:
THE REGULATION OF ATOMIC ENERGY FOR POWER GENERATION

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I. THE LEGISLATIVE BASIS FOR REGULATION

Governmental involvement has been a major feature of the atomic energy industry not only from its inception, but even prior to its existence in any recognizable form. As a result of the peculiar conditions of World War II - including, it has been argued, the presence of refugee scientists more attuned than their American counterparts to potential governmental interests - atomic energy was first developed for military use. It was appropriated by the defense establishment directly from university laboratories; and in some respects, it was diverted even earlier in the developmental process, before laboratory efforts to confirm theoretical hypotheses had actually begun. Thus, during the war years, development of knowledge about atomic fission processes in general, and construction of an atomic bomb in particular, were both made the exclusive responsibility of the Manhattan District, Army Corps of Engineers, Department of Defense.[1]

Once the war was over, there would be increasing pressures for a "normalization" of atomic energy, in the context of the presumed American commitment to free enterprise. But such pressures would be exerted upon an existing scheme of development, rather than in an institutional vacuum. Their effect would have to be measured in terms of incremental changes in the institutional pattern established during the war, rather than de novo. And that pattern was not generally considered a typical one. Many other industries have a history of increasing governmental regulation, as their attendant social benefits and costs emerge or are perceived. But the atomic energy industry has been a governmental protegé. As a result, its policy issues and debates have centered less on the positive need for regulation, than on the extent to which the scope of governmental responsibility could safely be reduced. It is my contention that this difference is primarily one of perspective, rather than substance. That is to say, the relationship between governmental regulation and industrial performance with regard to atomic energy is amenable to essentially the same analytic questions and techniques as are used in evaluating other regulated industries. Nonetheless, the difference in perspective does remain. It is therefore important to understand the development of the government-industry relationship over time.

The Atomic Energy Act of 1946

The first break in the wartime pattern was passage of the Atomic Energy Act of 1946. However, the major issue in its debate was not whether the development of atomic energy should continue to be focused on military uses, although that question was a source of concern, particularly for scientists. Rather, the debate centered on the degree to which there should be civilian control of such development. Although technically the Army Corps of Engineers, including its Manhattan District,

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was subordinate to a civilian Secretary of Defense, a greater degree of civilian control was desired. Thus, the new Act created a five-member, civilian, Atomic Energy Commission (AEC) to exercise control over the sources of radioactive materials. It would both supervise the production and use of atomic materials, and be responsible for the further development of atomic energy technology. Nonetheless, the orientation remained one of primary concentration on military uses; and secrecy also continued to be a major concern. As a consequence. the new Commission's powers were explicitly designed to be unusually broad. It was, for example, described by the Act's legislative drafters as "an island of socialism in the midst of a free enterprise economy."[2] In part for that reason, the Act also created a corresponding Congressional committee with broad authority to obtain information from the Commission, in order to oversee its activities effectively. On the other hand, since the Joint Committee on Atomic Energy (JCAE) comprised nine members each from the Senate and the House of Representatives, it would be the sole source of substantive, as opposed to budgetary, oversight by the Congress. And many of its deliberations would take place in executive session.

However, a further mitigating factor in the Commission's potential for effective monopoly was provided by its own policy of contracting for most of its operational responsibilities, with selected universities and corporations. Although there were very narrow limits both on the number of entities involved, and on the degree to which they could take advantage of the knowledge gained from their affiliation with the AEC in their other

activities, there was at least some exposure of elements in the private sector to the new field.

Under this general organizational pattern, the United States developed its first stockpile of radioactive materials and weapons. Concomitantly, it also made some strides in the development of nuclear reactors for power generation, primarily as an offshoot of its military programs.[3]

The Atomic Energy Act of 1954

By the early 1950's, a number of new developments impinging on atomic energy had occurred. The nuclear monopoly thought to be held by the United States had been broken by the Soviet Union and Britain, so that attempts to maintain absolute secrecy were no longer seen as possible, or necessarily desirable. The new Republican Administration was committed to reducing the scope of governmental activity and encouraging private enterprise. President Eisenhower personally proposed an "Atoms for Peace" program before the United Nations, to promote international cooperation in the development of peaceful uses for the new technology. Scientific opposition to its continued focus on military applications had grown. The Joint Committee on Atomic Energy had become restive with the pace of development provided by the Atomic Energy Commission. And industrial interest in new applications of atomic energy had increased sufficiently to engender the formation of an Atomic Industrial Forum in 1953, to serve as a trade association.

In keeping with such changes in circumstance, the debate over new legislation for atomic energy no longer centered on the indirect issue of

civilian control, as it had in 1946. Rather it focused directly on the desire for civilian applications of the new technology, and on the potential for an atomic energy industry in the private sphere. There tended to be general agreement on the desirability of fostering the use of atomic energy as a source of power for civilian uses, so long as its continued availability for military needs was not undermined. There was considerable division, however, on the question of whether that application could, or should, be developed under essentially private, rather than public, auspices. This aspect of the debate was further complicated by the simultaneous eruption of the Dixon-Yates affair, which drew the AEC into the longstanding argument between advocates of public and private utilities.[4]

The end of the federal monopoly. The new Atomic Energy Act of 1954 which emerged from the legislative debate remained in force for twenty years, although it was amended in several respects during that time. Its major effect was to break the federal government's monopoly on the use of radioactive materials, by providing for their lease to private industry - or, as a result of the Dixon-Yates controversy, to public utilities - for the purpose of power generation. As a consequence, the arena for policy debate about atomic energy was removed, at least potentially, from the confines of intragovernmental discussion. Moreover, the basic regulatory pattern for the use of atomic energy in central station power plants was established. The primary form of regulation would be the issuance of licenses, although secondary and related efforts

would focus on standard setting for license applications and enforcement of license conditions. In this respect, therefore, the AEC's regulatory role would be similar to that of the FCC, which issues broadcast licenses, and dissimilar to that of the FPC, which regulates prices and rates of return directly.[5]

The separation of military and civilian programs. Another consequence of the new legislation was the creation of a dichotomy between the military and civilian aspects of the atomic energy program. Heretofore, the two had been linked in an overall reactor development program. Thus, considerable emphasis had been place upon so-called 'dual purpose' reactors which could be used either for weapons production or for power generation. And in the early 1950's, the AEC had actually involved a larger number of firms in its reactor programs.[6] Now, however, the Commission would be responsible for reactor development both for military purposes, and explicitly for power generation as an independent goal in itself.

Responsibility for the military uses of atomic energy would remain the sole province of the federal government, with private firms involved only as contractors. The AEC would continue to be responsible for producing the fissionable materials required by the Department of Defense (although it has been suggested that the relationship typically ran the other way, with Defense using or at least accepting, whatever the AEC said it could produce). This side of the agency's responsibility remained subject to strict security classification. As a consequence, it is not

readily amenable to analysis except for very limited purposes, and with limited data - primarily the records of the budgetary process.[7] However, for our purposes, the major point to be made about the defense aspects of atomic energy is that they have continued to be a major concern and responsibility of the AEC. The details of such programs are on the whole less important than the mere fact of their existence, and their consequent potential for affecting the course of the civilian program, directly or indirectly.

The promotional-regulatory combination. By contrast with the secrecy and restriction associated with the military side of atomic energy, the 1954 Act gave the AEC a mandate to promote more extensive diffusion of atomic energy in the private and public utility sectors, subject only to the caveats that public health and safety and the common defense be adequately protected. It should be stressed, however, that this responsibility would involve continued research and development by the Commission and its contractors, as well as regulation of the new industry's actions. Thus, the 1954 Act established the basis for what was subsequently to become a major source of controversy - the combination of promotional and regulatory responsibilities in the same governmental agency.

The licensing process. It also established the basic outlines of the licensing process itself.[8] It is, first of all, the responsibility of the individual utility to take the initiative in proposing, planning, locating, and building a nuclear power plant. It is the function of the

Atomic Energy Commission to review such proposals, on a case-by-case basis, to insure that the safety of the public will be protected; and the utility must obtain concurrence from the Commission before actually implementing its plans. The review and licensing procedures of the Commission are divided into two sequential stages. First, the utility applies for permission to build a proposed plant. When the Commission is satisfied that the utility has made adequate preparations and has an acceptable plan, it issues a construction permit. Then, as the construction process is nearing completion, the utility must come back to the Commission for a further review. At that point, if its findings are favorable, the Commission issues the utility an operating license, which authorizes it to use the plant for power generation. Although the substantive focus of the Commission's review is somewhat different at the two stages of the licensing process, the procedural requirements are quite similar.

The first step in obtaining a construction permit is the utility's submission of a formal application. At that point, the applicant has already ordered the reactor components from the nuclear equipment vendors, and selected and acquired a reactor site. It is also his responsibility to obtain any additional permits or approvals required by other governmental agencies, although that process may proceed concurrently with the AEC's review. In submitting an application for a construction permit to the AEC, the utility pays a substantial application fee, and also furnishes proof of its ability to finance the proposed

construction. But the central part of the application is the Preliminary Safety Analysis Report (PSAR), which typically runs to several volumes:

> "This represents the design criteria and preliminary design information for the proposed reactor and comprehensive data on the proposed site. The report also discusses various hypothetical accident situations and the safety features which will be provided to prevent accidents or, if they should occur, to mitigate their effects on both the public and the facilities employees."[9]

Although the application materials are made available to the public at the time that the Commission formally dockets the case, the second major step in the licensing process is review of the application by the Commission's Regulatory Staff. That review is an extensive one, and the Staff may require whatever additional information it needs from the applicant. It may also consult with other governmental agencies in their areas of expertise. A description of the technical review's principal features was published by the AEC in 1973:

> "1. A review is made of the population density and use characteristics of the site environs, and the physical characteristics of the site, including seismology, meteorology, geology and hydrology to determine that these characteristics have been determined adequately and have been given appropriate consideration in the plant design, and that the site characteristics are in accordance with the siting criteria (10 CFR Part 100), taking into consideration the design of the facility including the engineered safety features provided.
>
> 2. A review is performed of the design, fabrication, construction, testing and expected performance of the plant structures, systems and components important to safety to determine that they are in accord with the regulations, regulatory guides, and other requirements, and that any departures from these requirements have been identified and justified.
>
> 3. Evaluations are made of the response of the facility to various anticipated operating transients and to a broad spectrum of hypothetical accidents. The potential consequences of these hypothetical accidents are then evaluated conservatively to determine that the calculated potential offsite doses that might result, in the very unlikely event of their occurrence, could not exceed appropriate guidelines for site acceptability....

> 4. A review is made of the applicant's plans for the conduct of plant operations including the organizational structure, the technical qualifications of operating and technical support personnel, the measures taken for industrial security, and the planning for emergency actions to be taken in the unlikely event of an accident that might affect the general public. This review is used to determine whether the applicant is technically qualified to operate the plant and whether he has established effective organizations and plans for continuing safe operation of the facility.
>
> 5. Evaluations are made of the design of the systems provided for control of the radiological effluents from the plant to determine that these systems can control the release of radioactive wastes from the station within the limits specified by the regulations and that the applicant will operate the facility in such a manner as to reduce radioactive releases to levels that are as low as practicable."[10]

The Regulatory Staff's conclusions are presented in a Safety Evaluation Report (SER).

The third major step in the licensing process is review of the application by the Advisory Committee on Reactor Safeguards (ACRS), which comprises up to fifteen non-AEC scientists appointed by the Commission for four-year terms. Copies of each application are given to the ACRS at the time of their original submission; and a subcommittee is appointed to keep track of each particular case as it undergoes the Regulatory Staff's review, and to note any modifications. The subcommittee then prepares a report of its own, which is submitted along with the Regulatory Staff's completed Safety Evaluation Report to the full Committee. The Advisory Committee also meets with the Regulatory

Staff and the applicant. It then submits a report, written as a letter to the Chairman of the Commission. At that point, the Regulatory Staff updates its review in a Supplemental Safety Evaluation Report, which also addresses any new questions raised by the ACRS.

Once all of these technical reviews are complete, the final step in the licensing process for a construction permit is the public hearing. Its task is to determine:

> "1. whether the application and the record of the proceeding contain sufficient information for assessment of the radiological safety and environmental impact of the proposed facility and
>
> 2. whether review of the application by the AEC Regulatory Staff has been adequate to support the findings proposed to be made by the Director of Regulation and to support issuance of a construction permit. For a contested hearing, the licensing board also considers the contentions and testimonies of the intervening parties."[11]

The licensing board (or examiner) then issues an initial decision, granting or denying the construction permit. That finding stands as the decision of the agency, unless it is appealed to a special review board or the Commission itself, or they choose to review it on their own motion.

The Commission's staff continues to monitor the actual construction of the facility once the construction permit is granted. As it nears completion, the utility applies for an operating license by submitting a Final Safety Analysis Report (FSAR). It contains "plans for operation, procedures for coping with emergency situations, and pertinent details on the final design of the reactor itself - such as containment design,

design of the nuclear core, and waste handling system."[12] That report goes through essentially the same steps as the PSAR at the construction permit stage; detailed review by the Regulatory Staff, and resultant modifications; a Safety Evaluation Report and Supplement; a review and report by the ACRS; and, in some instances, public hearings. When the operating license is issued, it includes a detailed set of Technical Specifications, "which set forth the particular safety and environmental protection measures to be imposed upon the facility and the conditions of its operations that are to be met in order to assure protection of the health and safety of the public and of the surrounding environment."[13] The Commission then maintains an ongoing inspection program for the life of the license, to insure that the Technical Specifications are adhered to in practice.

There have been a number of modifications in the exact procedures followed by the Commission over the twenty-year period, 1954 to 1974, most of which are indicated in the following discussion. There have also been some significant substantive additions to the Commission's areas of concern over time. And in practice, there has been extensive informal interaction between applicants and the Commission staff, in addition to the requirements of the formal review process. But all of these variations have been implemented within the basic framework outlined above, so that every license application considered by the Commission has faced essentially the same series of steps in the regulatory process.

II. POWER REACTOR DEVELOPMENT

As noted earlier, a number of industrial firms had become involved in the AEC's reactor development program before the passage of the 1954 Act, under contracting arrangements. The same industrial pressures which contributed to the demand for new legislation had also resulted in a significant expansion in the number of such firms during the early 1950's. Then the licensing authority provided in the new Act greatly extended the potential for private involvement in atomic energy, at least in theory. But in practice, there proved to be unexpected difficulties and delays. As a result, it was 1957 before the outlines of the new government-industry relationship began to appear. However, in that year there were four major developments which foreshadowed many of the debates and issues concerning atomic energy to the present.

The Shippingport Reactor

The first nuclear power reactor of potentially commercial scale went critical only in 1957. It was located at Shippingport, Pennsylvania, near Pittsburgh, and it was owned by the AEC. In fact, it was a direct outgrowth of the Commission's program to develop a nuclear reactor-powered submarine for the Navy. Essentially, the reactor was a land-based version of the one used in the Nautilus. Thus, it was a light-water reactor of the pressurized-water type, and it was built by Westinghouse under contract to the AEC. Here was an obvious example

of the military development program having a direct effect on the form of the civilian one. But the Shippingport case also was an example of the AEC's desire to involve utilities directly in its development program, in order to gear it more realistically to industry needs. As the result of its response to an invitation for industrial participation issued by the AEC in 1953 - before the passage of the 1954 Act - the Duquesne Light Company of Pittsburgh built the associated electrical generation facilities at Shippingport, contributed substantially toward the cost of the reactor itself, gained title to the nonnuclear facilities, became responsible for the operation of the reactor once it was completed, and distributed its electrical output over the company's grid.[14] Part of the interest of the utilities in nuclear possibilities was apparently sparked by the desire to forestall the AEC's entry directly into such activities on its own. However, because Duquesne undertook its responsibilities on a contract basis, the plant was not subject to the licensing procedures newly established by the 1954 Act. Technically, it was authorized, rather than licensed, to operate.

The Fermi Reactor

A second industrial venture into the use of atomic energy for power production had been initiated in 1955 by the Power Reactor Development Corporation (PRDC), which comprised more than 30 corporate members, including Detroit Edison. The PRDC proposed to build a breeder reactor, to be named after the nuclear scientist, Enrico Fermi, some thirty miles

from Detroit. It therefore filed an application for a construction permit with the AEC. In 1956, as the licensing review unfolded, the AEC's statutory Advisory Committee on Reactor Safeguards (ACRS) filed an unfavorable report on the Fermi reactor. The committee particularly questioned its location so close to a major population center:

> "Although there are no facts or calculations available to the Committee that clearly indicate that the proposed reactor is not safe for this site, the Committee believes there is insufficient information available at this time to give assurance that the PRDC reactor can be operated at this site without public hazard."[15]

When the Commission Chairman, Lewis Strauss, chose not to publish the Committee's report, and the AEC subsequently approved the application for a construction permit, another AEC Commissioner, Thomas Murray, revealed the unfavorable finding. Senator Clinton Anderson of New Mexico, a member of the JCAE, then contacted a number of Michigan leaders and organizations. As a result, three labor unions petitioned to intervene in the AEC proceedings. When the AEC reaffirmed its decision to grant a construction permit to the PRDC, the unions went to court to have the permit set aside. Their request was initially granted by the U.S. Circuit Court of Appeals; but the AEC and PRDC took the case to the Supreme Court, where the Appeals Court decision was overturned in 1961. Thus, the Fermi reactor was ultimately licensed for construction. But it was plagued by operational difficulties, and its fuel core was eventually destroyed in a criticality accident, so that it was never operated commercially.[16] In the meantime, as a result of the controversy over the Commission's decision despite the

Advisory Committee's report, the Atomic Energy Act was amended. ACRS reports were made mandatory and public (although the Committee's deliberations remained secret), and public hearings were made a mandatory part of nuclear licensing proceedings.

The Fermi case was significant for a number of reasons, quite apart from its direct impact as an example often cited by nuclear critics. First, the choice of a breeder reactor, despite its technical difficulties and unknowns, reflected a concern over the availability of adequate nuclear fuel supplies, which was to continue to the present. Second, the conflict over the location of reactors near major population centers would also be a recurring one. It was the result of two competing, and perhaps even mutually exclusive, desires. In the face of uncertain technology, distance from population centers represented an additional safety factor. On the other hand, the technology and economics of the utility industry favored location of power generation facilities as near to major load centers as possible. Third, the Fermi case represented the first attempt by nonnuclear organizations to intervene in AEC licensing proceedings. Fourth, the outcome itself seems to be one that would subsequently become a fairly typical pattern: intervenors would lose the particular case, although they might delay the outcome; but there would be procedural changes in the licensing process in response to their objections. Fifth, the active involvement of both the courts and the members of the Joint Committee in the atomic energy decisionmaking process would be a recurring factor.

Finally, a favorable licensing decision - in subsequent instances, as in the Fermi case - would not necessarily mean that successful operation of the reactor would follow easily or quickly.

WASH-740

A third major development in 1957 was the AEC's publication of the so-called Brookhaven Report, designated as WASH-740. Prepared for the Commission by staff members of the Brookhaven National Laboratory, the report sought to assess the Theoretical Possibilities and Consequences of Major Accidents in Large Nuclear Power Plants.[17] Its major finding was that such an incident constituted a low probability - high consequence event. The major emphasis of the report was on the low probability, but it was the high consequence estimates which evoked strong public reaction. The report suggested that the casualty and damage figures for the "maximum credible accident" would not exceed 3,400 fatalities, 43,000 injuries, and $7 billion in property damage. Even though the probability of such an event might be very low, the large casualty figures proved disturbing. The report was a factor both in the Fermi reactor licensing case and in the debate over the need for governmental indemnity, which is discussed below. Even more significantly, for our purposes, the Brookhaven Report, or WASH-740, was subsequently to serve as a continuing source of alarm to nuclear power critics.

The Price-Anderson Act

The fourth major event with regard to atomic energy in 1957 was

the passage of the Price-Anderson Act of 1954, which dealt with the question of liability insurance for utilities who built nuclear power plants.[18] The need for liability protection in case of accidents had already posed somthing of a problem for the first companies involved in atomic energy. While the AEC, as part of the federal government, was not liable to private suit, its contractors were not so protected. However, the early reactors had been relatively small, and had been built for the most part at remote locations. The companies involved had absorbed most of the risk as a cost of obtaining the contract relationship, and the AEC had also made limited provisions for governmental indemnity. Now, with the new plans to license utilities to operate larger reactors in less isolated areas, where they could contribute to high load requirements, greater amounts of insurance became a necessity. But simply obtaining liability insurance on the normal private market had two drawbacks. First, there was not sufficient operating experience with nuclear reactors for the insurance underwriters to employ their standard actuarial techniques to determine operating risks and consequent premiums. Second, the extent of the coverage required, particularly in light of the kind of figures outlined in the Brookhaven Report, seemed beyond the resources of the private insurance industry, let alone those of any existing company. The problem was mentioned only briefly in the original debate on the 1954 Act, and one critic has claimed that this was the result of a tacit agreement by the AEC and JCAE not to raise a potentially alarming

issue that might jeopardize public acceptance of atomic energy development.[19] But, by 1957, the apparent lack of sufficient liability insurance was being cited as a major drawback to further commitment by the utilities to nuclear power plants. On the other hand, like the utilities themselves, the insurance industry was not anxious to have the AEC move directly into its traditional area of activity. And Congress in particular was also concerned about the ability of members of the public who might be injured in a nuclear accident, to obtain financial redress.

The legislative answer to this range of concerns was a composite system. The first tier of liability would be covered by private insurance, which power plant owners would be required to purchase in order to obtain a license from the AEC. In order to provide this level of coverage, originally set at $60 million in 1957, the insurance industry formed a pool arrangement. Technically, there are two pools, one for stock companies, and one for mutual companies; but in practice they have operated in concert. It should also be noted that this insurance covers third-party liability only. Property insurance for the reactor owner is provided by a corresponding pool arrangement and by utility self-insurance.

A second tier of liability insurance over and above that available from private insurance and required of AEC licensees, would be provided by the federal government and administered by the AEC. This tier of protection would provide $500 million per plant per incident over and

above the $60 million paid by insurance. In return for this governmental indemnification, power plant licensees would be required to pay annual indemnification fees to the AEC; the size of such fees would be administratively determined, since there was no available method for scaling them to the size of the risk involved. For most cases, it constitutes $30 per year for each 1,000 KW(t) of capacity.

Finally, the Price-Anderson Act established an absolute limit on the level of liability to which any plant owner would be subject. That was set initially at $560 million, or the sum of the protection available from both private insurance and government indemnity. The provisions of the Act were originally limited to licenses in the first ten years after its passage; but they would apply for the duration of such licenses, typically about 40 years.

Again, as with the other modes of operation established with regard to atomic energy, Price-Anderson would become a continuing focus of criticism; in this instance, on dual grounds. First, it would be argued that it constituted a further and unjustified subsidy to the industry. Second, it would be maintained that its necessity constituted evidence of inadequate safety in the operation of nuclear reactors.

Licenses, 1957-62

Despite the AEC's attempts to subsidize the development of power generation facilities based on nuclear reactors, there was still only

a limited number of applicants. And since each plant was essentially custom-built, each licensing procedure was similarly individualized. It was only in 1959 that the first complete regulatory record was established, with the granting of an operating permit to Commonwealth Edison's Dresden 1 unit near Chicago. Ironically, it was one of two installations which had been financed entirely by the utility, with no direct AEC subsidies. Built by General Electric, which had also been a major contractor for the AEC, it was of the boiling-water type. A year later, in 1960, the first provisional operating license for a Westinghouse pressurized-water reactor was granted for the Yankee Rowe facility in Massachusetts, to a utilities group called Yankee Atomic Electric Company. In contrast to the Dresden plant, Yankee Rowe's builders had enjoyed some direct subsidies as part of the AEC's Power Reactor Demonstration Program.[20] Then, in 1961, the first recorded withdrawal of a license application took place, by the Florida West Coast Nuclear Group, Inc. However, because the subsequent polemic literature on questions of nuclear safety has failed to mention this particular plant, it is assumed for the time being that the reason was probably not directly related to the licensing process. It was, incidentally, at this time that the Supreme Court upheld the earlier decision of the AEC to grant the Fermi reactor's construction permit (see above).

In 1962, the pace of the licensing process picked up slightly, as three new plants were granted operating licenses. They were a

pressurized-water reactor built for Consolidated Edison at Indian Point, New York; a boiling-water reactor built for Consumers Power at Big Rock Point, Michigan; and a second boiling-water reactor, built for Pacific Gas and Electric at Humboldt Bay, California.[21] In addition, several more plants were planned or under construction. But the process of building a nuclear power plant remained essentially a customized one, and there were only a handful of plants in actual operation.

The 1962 Report to the President

It was in this context, in March 1962, that President Kennedy asked the AEC, in cooperation with other energy-related agencies, to prepare a report on the status of the civilian nuclear power program. The report, which the Commission submitted to the President in November, 1962, reaffirmed the desirability of the government's continuing its development program with regard to atomic energy, in order to provide a long term source of energy for the country's economic growth. It did stress the desire of the Commission to increase the role of private industry, particularly with regard to reactor types which were now at the stage of commercial development. But it also maintained the Commission's commitment to a continuing research and development program of its own on more advanced reactor models. In particular, it emphasized the need for a special effort to develop breeder reactors for the long-term, as well as for a continuation of its current program, with its focus on expanded utilization, in the short term, of less

fuel-efficient models.

Particularly interesting was the added emphasis placed in the report on the economic, as opposed to the technological, aspects of the program. The need for the technology of atomic energy to become competitive with other fuels for central station power plants was recognized. Yet the commitment to the development of such technology explicitly preceded any assurance of its ability to do so. Thus, the report explained the need for governmental involvement:

> "Since the product does not meet some hitherto unfilled need but rather must depend for its marketability upon purely economic advantages which, for some time, will be small compared to the investment, industry could not have afforded to undertake the development by itself."[22]

Such a policy of course raised the question of whether atomic energy was displacing other power generation fuels purely as a result of its government subsidies. But the Commission's report demurred:

> "Concern has been expressed lest conversion to nuclear power might cause severe dislocation in the coal industry and hence on transportation, especially the railroads. This is definitely not the case."[23]

Essentially, it was the Commission's contention that a rapidly growing market for electricity would be able to utilize growing inputs of both fossil fuels and nuclear power.

On the other hand, concern was expressed for the current position of nuclear vendors, who supplied and built reactor systems for the utilities. AEC Chairman Glenn Seaborg expressly raised the point in his letter of transmittal, which accompanied the 1962 report:

> "It should be recognized that, largely as a result of early optimism, we have, in a short space of time, developed a competitive nuclear equipment industry which is over-capitalized and under-used at the present time. This optimism has had some good results in terms of bringing many able technical men, manufacturers, and utility executives into the field, and assuring Congressional and industrial support during the development years.
>
> The optimism has also brought about some difficulties in that unless there are new starts in atomic power plants, the atomic equipment industry will probably dwindle down to fewer manufacturers than would be desirable for a healthy and competitive nuclear industry."[24]

Finally, the Commission's report addressed the question of the impact of its own regulatory requirements, then almost exclusively designed to insure public safety, on the willingness of the industry to commit itself to additional nuclear units:

> "Steps are being undertaken to simplify and streamline the licensing and regulatory procedures. A major step is the recent enactment of legislation that will reduce greatly the number of mandatory public hearings. The Commission is studying means to simplify its own licensing procedures by reducing the volume and complexity of administrative processes.
>
> The Commission is also studying ways to modify current regulations so that better guidance can be given to utilities on the suitability of specific reactor sites prior to their making substantial monetary outlays."[25]

Apparently, the requirements of government regulation, despite the corresponding advantage of government subsidies, were beginning to become a deterrent to industrial participation.

Procedural Changes

As noted in the Commission report, the number of mandatory public hearings required by the 1957 amendments to the Atomic Energy Act in

the aftermath of the Fermi ACRS report incident was reduced in 1962. Now, such hearings would only be mandatory at the construction permit stage of the licensing procedure; they would be held at the final, operating license stage only if there were appropriate intervenors, who would raise questions thought relevant and significant by the Commission. Moreover, in 1963, the Commission set up a new system of Atomic Safety and Licensing Boards, to replace its use of single hearing examiners in public hearings. Whereas the hearing examiners had been specialists in administrative law, the new Boards would also include scientific experts. An Atomic Safety and Licensing Board Panel of some twenty members, including both lawyers and atomic scientists was established. A three-person Atomic Safety and Licensing Board would be appointed from the Panel for each licensing case, either by the Commission or by the Panel Chairman (and Vice Chairman in his absence). The individual board would comprise one lawyer, who would preside at the hearing, and two scientists whose expertise was considered particularly relevant to the specific case. The aim of the new system was apparently to shift the focus of licensing hearings from legal procedures toward substantive questions of technology, and to reduce the need for lengthy background explanations by expert technical witnesses.[26]

Licenses, 1962-67

Despite the Commission's concern for the welfare of the nuclear industry, there was a definite lag in the licensing program. No new

operating permits were granted in the period 1963 to 1965, and the experimental reactor at Hallam, Nebraska, which had gone critical in 1962, was shut down in 1964. Moreover, there were two controversial applications to build nuclear power plants which were eventually withdrawn.[27]

In 1961, Pacific Gas and Electric Company, which was to obtain a provisional operating license for its first nuclear plant, at Humboldt Bay, California, in 1962, proposed to build a second plant at Bodega Head, about 50 miles north of San Francisco. When the utility's plans were made public in conjunction with its license application, local protesters objected to what they maintained would be the destruction of a scenic and previously undeveloped coastal site. Then it was discovered that the proposed site was in an area of extensive earthquake faulting. Questions were raised about the ability of reactor structures to withstand earthquakes, and about the safety of locating a nuclear power plant in such an area in the light of technological uncertainty and proximity to a major population center. After considerable controversy, the utility withdrew its application at the end of 1964.

In the meantime, the acceptability of locating nuclear reactors near major population centers had been questioned even more directly in the East. Consolidated Edison Company of New York had already obtained an operating license for its Indian Point plant in March, 1962. Later that year, it sought to build a second plant at Ravenswood,

in the heart of New York City, in the Borough of Queens. The utility had sought to address the question of whether distance from population centers was a necessary safety factor directly. But the public outcry over its proposal was so heated that Consolidated Edison withdrew its application early in 1964. For the first time since the Fermi controversy in 1956, the siting of nuclear power plants had become a subject of public controversy.

The Rise in Nuclear Plant Orders

In retrospect, the five-year period 1962-1967 was a time of major transition in the atomic energy industry, rather than one of decline. Despite the lag in the number of operating permits granted and new signs of public concern, the number of nuclear reactor orders suddenly began to surge in 1965. Apparently, there were several related developments. First, in 1964, the Atomic Energy Act was amended to permit private ownership of nuclear materials themselves. Previously, utilities had only been able to lease their fuel from the AEC, and there had apparently been concern over the possible impact of policy changes made after the investment in plants dependent upon nuclear fuel had taken place.

Second, the liability protection provided by the Price-Anderson Act was extended for an additional ten years, to licenses granted by 1977. The system remained essentially unchanged, except to reflect the somewhat larger amount of private insurance then available. Thus, although the limitation on total liability remained at $560 million,

the amount of private insurance required of licensees was increased from $60 million to $74 million; and the amount of governmental indemnity was correspondingly reduced. At the time of the bill's passage, the Joint Committee on Atomic Energy noted the improved position of the nuclear industry:

> "The Price-Anderson Act has clearly accomplished the second purpose for which it was enacted - removal of the deterrent to private industrial participation in the atomic energy program. This is obvious from the growth of the nuclear power industry and the huge increase in the scope and complexity of commercial nuclear energy activities."[28]

But it felt the Act should be extended "to ensure that this industrial activity would continue and expand." Moreover, the Committee argued:

> "Another relevant consideration is the dynamic nature of our national reactor development program. Although some power reactor types - the low conversion ratio light water reactors - are now being offered by manufacturers on a competitive basis with fossil-fuel plants, the long-range requirements of this program call for continued cooperation between government and industry in the development of the more advanced converter and breeder type reactors which hold the promise of a more effective utilization of nuclear fuel resources. The development of some of these more advanced reactors is at roughly the same stage today as was the case with low conversion ratio light water reactors in 1957, and this development should similarly be encouraged through extension of the Price-Anderson legislation."[29]

Third, there was a significant increase in the size of the nuclear reactors being built at this stage, which had a very favorable impact on their competitiveness with fossil-fuel plants. In 1967, Southern California Edison's plant at San Onofre, and Connecticut Yankee Atomic Power Company's unit at Haddam Neck received their operating licenses. Both were considerably larger than earlier demonstration plants; and

subsequent utility orders, beginning with Jersey Central Power and Light Company's Oyster Creek plant, and Niagara Mohawk Corporation's unit at Nine Mile Point, New York, would be explicitly considered "large scale."

Finally, in recognition of the greatly increased size of the reactors now being planned and ordered, the Commission initiated an update of the Brookhaven Report, on the extent of possible casualties and damages in the event of a "maximum credible accident." A working committee met and began making preliminary estimates, which looked as if they would be much larger than those presented in the 1957 WASH-740 report. But the study was discontinued before it was completed. It was only in 1973 that the incomplete working papers were placed in the AEC's Washington Public Document Room, along with a new Commission report on light-water reactor safety. As a result, in 1965 there was no public outcry comparable to that engendered by the original Brookhaven Report.

The 1967 Supplement to the Report to the President

Early in 1967, the AEC published a supplement to its 1962 report to the President at the request of the Joint Committee on Atomic Energy. In contrast to the guarded optimism of the original report, its supplement now noted that:

> "In the four years since the 1962 Report was issued, remarkable advances have taken place in the promise of nuclear power and in its acceptance by the U.S. utility industry as a new source of electrical energy. Continued operating experience with initial demonstration and experimental nuclear power plants and commitments to larger size demonstration plants have provided the necessary impetus for commitments by industry to large scale utility units."[30]

As a result, the projected development program concentrated much more explicitly on advanced reactors, particularly on various forms of breeder reactors. On the other hand, some of the earlier experiments were discontinued. The report supplement explained:

> "Evaluations since the 1962 Report have shown that some of the concepts described in the Report were only marginally superior to others whose success was nearer at hand and their development has been terminated. Other concepts have been discontinued because of especially difficult research or developmental engineering problems and the accompanying increased costs, delays, and difficulties associated with introducing the concept into the utility environment."[31]

Although the first high temperature gas-cooled reactor (HTGR) at Peach Bottom, Pennsylvania, received its operating license in 1966, several license applications for other reactor types were withdrawn in 1968, while others were considerably delayed. The light-water reactors, including both boiling-water and pressurized-water reactor types, were to be the backbone of the Commission's commercial power generation program, at least for the near-term.

Nonetheless, the Commission still remained cautious about claiming that nuclear power had achieved a state of full-scale commercialization. In both 1965 and 1966, the AEC declined to make a statutory finding of "practical value" under the provisions of the Atomic Energy Act. Such a finding would represent a formal acknowledgement of the technology's progression beyond the experimental and development stage. But the Commission found that, "although light-water reactor systems show economic promise as evidenced by utility orders, the degree of actual experience needed to confirm the status

of these concepts has not been obtained...."[32] On the other hand, the Commission's licensing procedures began to become more standardized, as greater experience was obtained, and the number of plants being built increased. In 1966, the AEC staff published its first "Guide to the Organization and Contents of Safety Analysis Reports." Progress was made in developing general design criteria for construction permits and an improved technical specifications system. It was noted too, in the 1967 Supplement to the report on Civilian Nuclear Power, that:

> "An increasing number of prospective applicants are meeting with the AEC staff in advance of filing applications to obtain informal views on siting questions, safety features of projected reactors, and information on licensing procedures. The regulatory staff also has offered the opportunity to manufacturers to conduct pre-licensing reviews of the reactor systems and components to reduce subsequent licensing time."[33]

Licenses, 1969-74

From 1969 on, there would be a continuing and increasing stream of operating licenses issued for additional nuclear units: four in 1969; four in 1970; five in 1971; six in 1972; and twelve in 1973. Orders, too, would continue to rise, until as of June 30, 1974, there would be a total of 212 reactor units operating, under construction, or on order.[34] Even larger increases would be projected to the turn of the century by the AEC. Nuclear energy had apparently passed the test of industrial acceptance. Future difficulties would emerge, in large part, from a different source.

III. THE INTERVENORS

With a few exceptions, the policy debates about the development of atomic energy remained a relatively limited affair until the late 1960's. Most of the participants were specialists, who were professionally involved - whether as scientists, lawyers, businessmen, or politicians. But then, citizen concern began to spread, probably at least in part in tandem with the increasing number and size of the proposed nuclear units themselves. Beginning in 1969, a number of books were published for general audiences, criticizing the way in which the technology of nuclear energy had been developed, and questioning the adequacy of provisions to protect the public health and safety.[35] Simultaneously, there seemed to be an increase in the number of scientists who were willing to become directly and personally involved in policy, as contrasted with narrowly scientific, debates. Public hearings in licensing cases were no longer attended only by the AEC's Regulatory Staff and industry representatives. There was a substantial increase in the number of formal interventions, and attempted interventions, in AEC proceedings. Whereas such cases had been isolated incidents before, the atypical licensing case tended to become one in which there were no potential intervenors. While, as noted earlier, the number of operating licenses granted for nuclear power plants by the AEC rose steadily from 1969, there was also a continuing rise in the number of applications withdrawn, albeit on a smaller scale.[36] Moreover, there were a number of court cases which dealt with issues concerning the AEC's exercise of its regulatory role.

The major change was an increase in the scope of the policy debate. Now there were more participants, more issues, and more arenas for debate. But the overall focus of the debate also shifted, from concentration on the need to develop an economically competitive atomic energy technology for power generation, to primary concern with issues of safety and of environmental acceptability.

Radiation Protection

The obvious and central hazard of using atomic energy is of course radiation; and so the first major issue to be raised was the adequacy of available protection from radiation exposure. The Commission had been aware of the need for strict control of exposure to radioactive materials from its inception; and both Atomic Energy Acts specifically mandated the AEC to be responsible for protection of the public health and safety with regard to radiation. Moreover, beginning in the 1950's, there had been considerable public concern over the radiation hazards to which the general population was exposed as a result of atmospheric nuclear weapons tests. Such concerns had eventually led to the nuclear test ban treaty. But now questions were raised as to the radiation exposure engendered by nuclear power generation plants and their support activities and facilities - for atomic industrial workers, for those in the immediate vicinity of various atomic energy installations, and for the public generally. Although the specific issue stressed varied somewhat over the 1969 to 1974 period, questions and objections would be raised

about the permitted level of routine radioactive effluents or releases, both from nuclear power plants themselves, and from the entire nuclear fuel cycle; and about the possibility and likelihood of unusual releases of radioactivity as the result of either accidents or acts of sabotage. Moreover, not only were there questions about the effectiveness of the Atomic Energy Commission in assuring that its contractors and licensees adhered to established radiation regulations; questions were also asked directly about the adequacy of the regulations themselves in protecting the health of atomic workers and the public.

Environmental Protection

In addition to the various forms of the radiation argument, a second set of more broadly environmental issues was also raised. Here the attitude of the Atomic Energy Commission was markedly different. The Commission had always recognized its responsibility for radiation hazards; indeed, the need for an unusual degree of regulation of the atomic energy industry was in large part justified as a consequence of its peculiar radiation dangers. But the AEC had never included in its mandate the responsiblity for other possible impacts from its development of atomic energy facilities. In fact, its proponents had argued that nuclear power plants were essentially nonpolluting, as compared to fossil-fuel plants. Thus, when it was suggested that the heat discharge from nuclear installations to adjacent bodies of water was creating problems of thermal pollution,[37]

the first reaction of the AEC was to disclaim responsibility. Such problems, if any, the Commission argued, were the concern of other governmental agencies, with other legislative mandates. In fact, the AEC Chairman, Glenn Seaborg, went so far as to argue that, "with respect to resolution of the thermal effects of cooling water discharges, we do not at present have legal authority in this area."[38]

New Hampshire v. AEC. When the State of New Hampshire questioned this interpretation, as implemented in an AEC licensing decision, in the Federal Courts, the AEC's position was upheld. In 1969, the U.S. Court of Appeals for the First Circuit ruled that the Commission's jurisdiction extended to radiological safety alone, however unfortunate the results of such a finding might be.[39]

Calvert Cliffs Coordinating Committee v. AEC. When the National Environmental Policy Act of 1969 was subsequently enacted, it required all federal agencies to prepare environmental impact statements for any actions or projects which would have a substantial impact on the environment. But, in keeping with its earlier interpretations of its mandate, and with the court ruling in the New Hampshire case, the AEC maintained that its responsibility and jurisdiction extended only to the radiological aspects of environmental issues. Hence, its proposed regulations for the implementation of NEPA's requirements were concerned only with the impact of radioactive emissions from nuclear power plants and other installations.

The Commission's interpretation was once again questioned in the courts, with regard to a proposed power plant in Maryland. However,

with the broadened language of NEPA in force, this time the ruling was different. In 1971, in Calvert Cliffs Coordinating Committee v. AEC, the U.S. Court of Appeals for the District of Columbia ruled that, "The Commission's crabbed interpretation of NEPA makes a mockery of the Act." Moreover, the court went on to outline extensive remedial steps:

> "This decision required that (1) NEPA be implemented for all licensing proceedings begun after January 1, 1970, and that this implementation include independent AEC assessment of water quality and other environmental factors at every important decision making stage, including a case-by-case cost-benefit assessment balancing environmental and non-environmental factors; (2) the licensing boards of the AEC (ASLB's) must give independent review to all NEPA matters in uncontested as well as contested cases; (3) the AEC must give prompt NEPA consideration to facilities for which permits and licenses were issued after January 1, 1970, if such matters were not substantially considered in the original licensing action; and (4) with respect to construction permits issued before January 1, 1970, the AEC must consider any significant non-radiological environmental impact and order such facility operations as may be needed."[40]

Minnesota v. Northern States Power Company. A third court case addressed the adequacy of the AEC's regulations with regard to radioactive standards, its primary area of concern, although it did so once again on jurisdictional grounds. The State of Minnesota had established radiation emissions standards which were dramatically more stringent than those of the AEC, although they were allegedly designed to be within the reach of existing technology for typical nuclear reactors. The State first sought to enforce its standards in 1968 in considering a waste-disposal permit for the Northern States Power Company, which had received a construction permit from the AEC

to build its Monticello plant. The company brought suit in the federal courts on the grounds that the Atomic Energy Act of 1954, as amended, constituted federal pre-emption with regard to radiation standards and emissions controls, so that the State lacked authority to act in that field. The U.S. District Court ruled in favor of the company in 1971, and the decision was subsequently upheld by the Supreme Court. As a consequence the states can only regulate radioactive emissions from nuclear power plants indirectly, by setting water quality standards.[41] Although with different implications for the substance of regulation than the Calvert Cliffs case, Minnesota v. Northern States Power Company had the same procedural effect: the central arena for debating the impact of nuclear power development would remain the AEC. Other institutional influences would have to be mediated by their effects on the Commission itself.

Organizational Changes

Nor was the agency to prove impervious to forces for change, despite assertions to the contrary by opponents of nuclear power. The period since the emergence of the intervenors as a continuing factor has been one of repeated organizational change. In December 1970, Congress amended the Atomic Energy Act to require that the AEC include in its licensing process an antitrust review of applicants in cooperation with the Department of Justice. The Calvert Cliffs case of course imposed extensive new requirements on the Commission,

as noted above. And more recently, there have been attempts, some successful and others not, to use the courts to force the Commission to take specific policy actions in areas of current debate.

The creation of the Environmental Protection Agency (EPA) by the National Environmental Policy Act of 1969 also brought another governmental agency directly into the field of atomic energy, since the EPA was given responsibility for setting radiation standards for health protection purposes. Previously, the Atomic Energy Commission had based its regulations on standards set by a private scientific organization, the National Council on Radiation Protection (NCRP), and reviewed by a Cabinet-level Federal Radiation Council. Although the Commission retains the responsibility for determining permissible levels of radioactive effluents from nuclear installations, it must now take into account the independent determination, with technological staff support, of permissible exposure standards by another agency, from the perspective of another legislative mandate. And the EPA's Office of Radiation Protection has taken active steps to develop its own stance on the question of radiation standards. It has, for example, issued a report on the concept of an environmental dose commitment for radiation exposure, which permits consideration of long-term effects from repeated low-level exposures.[42] Use of such a concept in establishing legal standards, in place of annual exposure limits set by the AEC could conceivably have a substantial effect on the permitted expansion of nuclear power generation facilities.

Similarly, the EPA has also prepared an extensive critique of the AEC's draft environmental impact statement for its LMFBR program.[43]

Public access. However, the Commission has also made extensive attempts on its own initiative to respond to the concerns of its critics. In part, at least, such efforts correspond to a change in personnel, with the appointment first of James Schlesinger, in 1971, and then of Dixy Lee Ray, in 1973, as chairmen of the Commission. Neither had previous connections with the atomic energy field, and both were explicitly committed to opening up the Commission's decisionmaking to greater public scrutiny, and even debate. Indicative of this attitude is the fact that the AEC did not appeal the Calvert Cliffs decision, despite its stringent requirements. And the Commission has in fact devoted extensive manpower to fulfilling its newly defined obligations. In 1972, the Commission's Rules of Practice were revised to facilitate public participation in licensing proceedings. It has also made available much more extensive information about the development and operation of atomic installations. In part, this has involved making a greater proportion of the documentary materials submitted in support of licensing applications available in the public documents room. In part, it has involved a vastly increased publications effort on the part of the Commission. For example, the Oak Ridge National Laboratory's bimonthly journal on Nuclear Safety, now includes summary reports on all unusual occurrences at nuclear installations. The Commission has also published, at the request of the JCAE, an extensive report on The Safety of

Nuclear Power Reactors (Light Water Cooled) and Related Facilities,[44] which draws together a considerable technical literature. And it has now published an extensive series of regulatory guides which lay out in considerable detail the kinds of standards which it requires of license applicants. The end result is a vast array of published material for those who have the resources to utilize it. In 1973, meetings of the ACRS were also opened to the public for the first time.[45] Thus, the Commission seems to have quite thoroughly reversed its earlier practice of extensive secrecy in its decisionmaking. In addition, the AEC has made several even more substantial changes in its own procedures and organization, largely in response to the criticisms of the intervenors.

Rulemaking hearings. The first of these is the Commission's institution of so-called rulemaking hearings for subjects of generic concern with regard to light-water reactors. A major complaint of the intervenors had been that the same issues had to be raised repeatedly in each licensing case in order to have an overall impact on the course of atomic energy development, since the Commission operated exclusively on a case-by-case basis. This condition posed a severe strain on the resources of what were essentially voluntary organizations. In response to such criticism, the AEC held its first rulemaking hearings, on the permissible levels of radioactive releases from nuclear installations, in 1971. These eventually resulted in adoption by the Commission of regulations which required nuclear plants to keep their radioactive releases "as low as

practicable," rather than simply within a preestablished limit. It subsequently held extensive and controversial rulemaking hearings on the criteria required of license applicants' Emergency Core Cooling Systems, for controlling the potential for radioactive releases in the event of a loss-of-coolant accident (LOCA). The Commission has also used the device of rulemaking hearings for questions relating to the nuclear fuel cycle, and to quality control requirements for nuclear licenses.

Separation of regulation and development. A second major change has been implemented in the Commission's organization of its own supporting staff. A repeated complaint of nuclear critics had been that the inclusion of the Commission's safety research program within its division for reactor technology development, as well as the linkage of regulatory and developmental functions within the same agency, inevitably subordinated the requirements of safety to the desire for greater diffusion of nuclear technology. In fact, this question had been given serious thought long before the intervenors became regular participants in the licensing process. For example, in 1961, a book published as the product of the University of Michigan Law School's Atomic Energy Project discussed the question extensively, and recommended that the advantages to be gained in knowledgeable regulatory personnel from the combination of the two functions outweighed any disadvantages with regard to conflicting policy goals.[46] In the face of increasing criticism on this score in the early 1970's, however, the Commission separated its safety

research program from its general program of reactor technology development, and even supported an Administration proposal to create two completely new agencies to be responsible for developmental and regulatory activities, respectively. In anticipation of that division, in 1972, the Commission began to publish its annual report to the Congress in two separate volumes, one on "Operating and Developmental Functions" and the other on "Regulatory Activities."[47]

Price-Anderson revision. A third area in which the Commission was responsive to external criticism was that of governmental indemnity for the owners of nuclear power plants. The extended Price-Anderson Act was not due to expire until 1977. But it was argued that because of the long lead time required to bring a nuclear plant on line, utilities were already being adversely affected in their decision-making by the fact that the Act might not be renewed in the face of continued criticism. AEC Chairman Schlesinger, who was leaving the Commission for another post, specifically indicated that he felt the Act's special provisions were no longer necessary; and subsequently, Chairman Ray reportedly concurred in that judgment.[48] Although Congress declined to eliminate the provisions of the Price-Anderson Act altogether, its provisions were modified, with the concurrence of the Commission, to phase out its governmental indemnity aspects over time, in favor of a system of contingency fees and increased private insurance. The amount of coverage to be provided per incident per plant was also substantially increased.

The Rasmussen report. Finally, a recurring complaint of

nuclear power critics had been that the AEC failed to update publicly its controversial Brookhaven Report of 1957, to allow for the greatly increased number and size of currently scheduled nuclear plants. In June 1973, the Commission released the working papers and internal memoranda for the uncompleted 1965 update of WASH-740, in conjunction with its new reactor safety report (see above). Then, in August 1974, it published a completely new evaluation. An Assessment of Accident Risks in U.S. Commercial Nuclear Power Plants, in conjunction with its ten appendices, represented the outcome of a two-year study under the direction of MIT Professor of Nuclear Engineering, Norman Rasmussen. Using event and fault tree methodologies, the study sought to establish a probabilistic risk assessment of the operation of 100 nuclear power plants currently licensed or under construction. In contrast with the findings of the 1957 WASH-740 Report, the Rasmussen Study (WASH-1400) finds that the overall risk of a nuclear accident - including the consequences as well as probability of occurrence - is very low. While the Rasmussen study's assumptions and methodologies are still open to criticism, as is the Commission's assessment of its significance, its completion and publication represent a serious effort on the part of the AEC to respond in a substantive way to the assertions of its critics.

Streamlining the regulatory process. While much of the AEC's attention has been focused on the intervenors in recent years, particularly with regard to the licensing of plants utilizing existing light-water reactor technology, the Commission has also

maintained its concern for the well-being of the nuclear industry. This fact was reflected in the early request for consideration of extension of the Price-Anderson Act cited above. And it is demonstrated even more directly in the recent attempts by the Commission to streamline its regulatory process in response to complaints by the industry that the intervenors were causing costly and unnecessary delays in bringing nuclear plants on line.[49] Such complaints were given extra force by the eruption of the so-called "energy crisis" in the wake of the Arab oil embargo, and by the Nixon Administration's commitment to Project Independence. The feasibility of such a policy of energy self-sufficiency would depend heavily on an increasing use of nuclear power for the generation of electricity. In addition, AEC Chairman Dixy Lee Ray was asked by President Nixon to prepare a report on The Nation's Energy Future,[50] so that the Commission was directly aware of the issue's salience. As a consequence, the Commission is currently committed to a major effort to reduce the lead time for bringing nuclear power plants on line. Besides attempting to speed up its current case-by-case review procedures, it has implemented licensing changes which greatly encourage standardization of plant design. These include three options. Under the Reference System approach, the technical review of the design for either an entire facility or a substantial part of it can then be referenced for additional plants using the same design, without further detailed regulatory review. Applications have been submitted for standardized nuclear steam supply systems

under this option, and standard plant design applications are under consideration by some utilities. The second option, known as the Duplicate Plant approach, allows a single technical review for several identical plants, which are to be constructed at different sites by a single utility or utility group within a limited time period. Again, an application has been submitted under this option, and others are being planned. Finally, the License to Manufacture option provides a single licensing review for the manufacture of identical reactors at a central location, for subsequent transportation to different sites. This last procedure was designed originally for offshore, barge-mounted plants.[51] In addition, the Commission has developed legislative proposals for even more extensive streamlining of its license review process.

Continuity in the issues. The Commission has also continued its commitment to a strong developmental program, with particular emphasis on breeder reactors. And it has placed heavy emphasis on the effort to involve private industry in the building of a breeder demonstration plant. It has made exploratory efforts to encourage private industry to take responsibility for developing further capacity for uranium enrichment services, a task previously undertaken solely by the AEC. Thus, there is considerable continuity in the pattern of policy issues engendered by the atomic energy industry, even though the specific aspects of the technology most directly involved have changed over time.

At the same time, the efforts by the AEC to respond to criticism by nuclear intervenors have not eliminated the latter's role in the decisionmaking process. As in the case of the nuclear industry, it is only the specific issues which have changed. Current controversy focuses primarily on the failure of the AEC to develop a permanent system of disposal for high-level radioactive wastes before licensing the plants and installations which produce them; on the alleged inadequacy of AEC procedures to protect the public from radioactive releases as the result of acts of nuclear sabotage; and on the advisability of pursuing further the Commission's program for development of the breeder reactor, and particularly the sodium-cooled LMFBR, in the face of allegedly adverse cost and safety features. On the procedural side, the same situation prevails. Now that the contention of the nuclear critics that the AEC's promotional and regulatory responsibilities should be vested in separate agencies is about to be implemented by the legislation establishing the Energy Research and Development Administration, and the Nuclear Safety and Licensing Commission,[52] the focus of concern has shifted. It is currently argued that there should be a moratorium on further licensing of nuclear plants until the substantive points of controversy can be resolved.[53] There is still no general agreement on what the goals of the atomic energy program should be, or how its decisionmaking procedures should be structured in order to achieve them. That basic lack of agreement is an overriding characteristic of the literature on atomic energy which has been reviewed.

NOTES

1. For a detailed account of the wartime period, see the first volume of the AEC's official history, Richard G. Hewlett and Oscar E. Anderson, Jr., The New World, 1939/1946 (University Park: Pennsylvania State University Press, 1962).

2. James R. Newman and Byron S. Miller, The Control of Atomic Energy, A Study of Its Social, Economic, and Political Implications (New York: McGraw-Hill, 1948); cited in Hewlett and Anderson, The New World, p. 5.

3. For a detailed account of the AEC's early history, see the second volume of the AEC's official history, Richard G. Hewlett and Francis Duncan, The Atomic Shield, 1947/1952 (University Park: Pennsylvania State University Press, 1972). A brief account of the early development program is given by Oliver Townsend, "The atomic power program in the United States," pp. 35-79, Atoms for Power: United States Policy in Atomic Energy Development (New York: The American Assembly, 1957).

4. A detailed account of the complex events in this incident is given in Aaron Wildavsky, Dixon-Yates, A Study in Power Politics (New Haven: Yale University Press, 1962).

5. See William O. Doub, chairman, Federal Energy Regulation: An Organizational Study, Prepared for public, Congressional, and agency comment by the Federal Energy Regulation Study Team (Washington, D.C.: U.S. Government Printing Office, 1974); Roger G. Noll, Merton J. Peck, and John J. McGowan, Economic Aspects of Television Regulation (Washington, D.C.: The Brookings Institution, 1973); and Stephen G. Breyer and Paul W. MacAvoy, Energy Regulation by the Federal Power Commission (Washington, D.C.: The Brookings Institution, 1974).

6. See Townsend in Atoms for Power.

7. There is some discussion of the JCAE's role in encouraging specific military programs in Harold P. Green and Alan Rosenthal, Government of the Atom, The Integration of Powers (New York: Atherton Press, 1963).

8. This description is based primarily on U.S. Atomic Energy Commisssion, The Safety of Nuclear Power Reactors and Related Facilities, (WASH-1250), 1973, Chapter 3, "The Government's Regulatory Role." As a result, some of its specific terms are not accurate for the entire twenty-year period. For example, licensing boards were not created until 1963; previously, the same function was performed by a single hearing examiner.

9. WASH-1250, p. 3-12.

10. Ibid., pp. 3-13 and 3-14.

11. Ibid., p. 3-16.

12. Ibid., p. 3-17.

13. Ibid.

14. Townsend, Atoms for Power, p. 65.

15. Cited in Richard Curtis and Elizabeth Hogan, Perils of the Peaceful Atom, the Myth of Safe Nuclear Plants (Garden City, New York: Doubleday & Company, 1969), p. 9.

16. Ibid., pp. 7-16.

17. See Sheldon Novick, The Careless Atom (Boston: Houghton Mifflin Company, 1969), pp. 62-66.

18. The most recent studies of Price-Anderson, as well as some background materials, are compiled in Joint Committee on Atomic Energy, Selected Materials on Atomic Energy Indemnity and Insurance Legislation, March 1974. Similar volumes were published in 1957 and 1965.

19. Harold P. Green, "Nuclear Power: Risk, Liability, and Indemnity," Michigan Law Review, vol. 71, no. 3 (January 1973), p. 490.

20. See Townsend, Atoms for Power, pp. 67-68.

21. Licensing information is based on U.S. Atomic Energy Commission, "Facilities License Application Record," dated March 31, 1974.

22. U.S. Atomic Energy Commission, Civilian Nuclear Power - A Report to the President 1962, p. 27; reprinted in Joint Committee on Atomic Energy, Nuclear Power and Related Energy Problems - 1968 through 1970, December 1971, as Appendix 1.

23. Ibid., p. 61.

24. Dated November 20, 1962; reprinted in JCAE, Nuclear Power, p. 240.

25. Civilian Nuclear Power, 1962, p. 60.

26. In 1969, the Commission also delegated its review responsibilities to an Atomic Safety and Licensing Appeal Board drawn from the members of the Atomic Safety and Licensing Board Panel. In 1971, the Appeal Board's membership was separated from that of the Licensing Board Panel; and in 1972, that single Appeal Board was replaced by a separate Appeal Panel, comparable to the Licensing Board Panel.

27. Steven Ebbin and Raphael Kasper, Citizen Groups and the Nuclear Power Controversy: Uses of Scientific and Technological Information (Cambridge, Massachusetts and London: The MIT Press, 1974), pp. 11-12.

28. JCAE Report No. 883, 88th Cong., 1st Session, August 26, 1965, p. 5; cited in JCAE, Selected Materials, 1974, p. 3.

29. Ibid.

30. U.S. Atomic Energy Commission, Civilian Nuclear Power - The 1967 Supplement to the 1962 Report to the President, p. 2; reprinted in JCAE, Nuclear Power, as Appendix 2.

31. Ibid., p. 11.

32. Ibid., pp. 11-12.

33. Ibid., p. 56.

34. The figures for operating licenses are tabulated from the AEC's "Facilities License Application Record," cited above. The 1974 figure is taken from AEC Press Release T-357, dated July 19, 1974. The 212 reactors include 45 licensed by the AEC to operate; 2 owned by the AEC and authorized to operate; 65 under construction; and 105 planned and reactors ordered.

35. Curtis and Hogan, and Novick, cited above; John W. Gofman and Arthur Tamplin, 'Population Control' Through Nuclear Pollution (Chicago: Nelson-Hall, 1970), and Poisoned Power (Emmaus, Pa.: Rodale Press, Inc., 1971); Harry Foreman, ed., Nuclear Power and the Public (Garden City, New York: Doubleday & Company, Inc., Anchor Books, 1972); Richard Lewis, The Nuclear Power Rebellion, Citizens vs. The Atomic Industrial Establishment (New York: Simon and Schuster, 1972).

36. One application was withdrawn in 1969; one in 1970; two in 1971; three in 1972; and five in 1973. Facilities License Application Record.

37. A detailed case study which deals with this issue is Dorothy Nelkin, Nuclear Power and Its Critics, the Cayuga Lake Controversy (Ithaca and London: Cornell University Press, 1971).

38. AEC Report on "Nuclear Power and the Environment," Proceedings, University of Vermont, Burlington, Vermont, September 11, 1969, p. 94; cited in Ebbin and Kasper, Citizen Groups, p. 13.

39. Ebbin and Kasper, pp. 94-95.

40. Ibid., pp. 30-31.

41. Lewis, Nuclear Power Rebellion, pp. 122-126.

42. U.S. Environmental Protection Agency, Office of Radiation Programs, Environmental Radiation Dose Commitment: An Application to the Nuclear Power Industry, February 1974, (EPA 520/4-73-002).

43. U.S. Environmental Protection Agency, Environmental Statement Comments, Liquid Metal Fast Breeder Reactor Program, April 1974, (EPA/D-AEC-00106-00).

44. WASH-1250, cited above in note 8.

45. U.S. Atomic Energy Commission, 1973 Annual Report to the Congress, Volume 2 - Regulatory Activities, p. 4.

46. William H. Berman and Lee M. Hydeman, The Atomic Energy Commission and Regulating Nuclear Facilities (Ann Arbor: University of Michigan Press, 1961).

47. See 1973 Annual Report, Volume 2, pp. 7-8.

48. "Separate View of Representative Teno Roncalio," JCAE Report No. 93-1115, 93rd Congress, 2nd Session, Revising and Amending the Price-Anderson Indemnity Provisions of the Atomic Energy Act of 1954, As Amended (Washington, D.C.: U.S. Government Printing Office, 1974), p. 27.

49. AEC Press Release T-169, dated April 16, 1974, outlines the findings of a Report on Construction Delays which followed a series of meetings between the AEC and electric utilities and contractors. AEC Press Release T-281, dated June 10, 1974, outlines the features of "Action Plan No. 2," which was the outgrowth of a second construction delays report.

50. WASH-1281, dated December 1, 1973.

51. 1973 Annual Report, Volume 2, pp. 16-19.

52. As of October 10, 1974, a conference bill had passed both Houses of Congress and had been sent to the White House. Los Angeles Times, October 11, 1974.

53. This view has been espoused most vocally by Ralph Nader, but it is gaining wider concurrence among public interest groups concerned with atomic energy regulation.